

Studies of Adsorption of Contaminants onto Viscous Liquid Barriers

S.E. Borglin¹, G.M. Lamble^{1,2} and G.J. Moridis¹

¹Earth Sciences Division, Lawrence Berkeley National Laboratory, Berkeley, CA 94720, USA

²Advanced Light Source, Lawrence Berkeley National Laboratory, Berkeley, CA 94720, USA

Contaminants in the subsurface can be contained by injection of viscous liquid barriers [1,2]. These barriers, formed by injection of a low viscosity liquid which gels after placement in the subsurface, reduce the permeability of the porous media surrounding the contaminants and thereby inhibiting the flow of potentially toxic agents to groundwater. There are several chemical formulations that are used in liquid barriers technology. Recent work [3] has suggested the use of injectable colloidal silica barriers that contain magnetite. The addition of magnetite would facilitate the precise placement of the grouting liquid during the gelling process. The stabilized colloidal silica-magnetite fluid, called a ferrofluid, can be held in position during the gelation process using permanent or electromagnets, thus providing a means of precise placement of the barrier.

To evaluate the long term stability of this type of barrier, an understanding of the interaction of the entrapped contaminants with the barrier material is needed. The interaction of the contaminant species with the barrier can result in either surface adsorption, chemical transformation, or diffusion through the barrier. Any of these phenomena can effect the mobility of the contaminant in the subsurface.

To understand the interaction process, information on the contaminants, for example Cs and Cd, on the surface of the barrier is needed. Microscale measurements of elemental distribution of contaminants on the barrier surface would reveal both the adsorption patterns and chemical speciation of the contaminants. This, along with macroscale measurement of barrier integrity, would reveal information on the stability and the longevity of subsurface barriers. Detailed knowledge of chemical-barrier interactions would lead to the development of more effective barrier systems.

Initial investigation by μ -XAFS of the ferrofluid barrier material gelled in the absence of a magnetic field by has shown detailed iron self-organization patterns on the barrier surface (see Figure 1). The patterns are a combination of small circular accumulations and longer striated patterns. Initial measurement of the iron in the circular shaped areas may indicate a non-magnetic form of iron. Barrier material exposed to cesium shows adsorption in a network or web pattern, not associated with the striated iron patterns (Figure 2). We can see that the Fe still shows striated 'self-organization'. The cesium, however, shows quite a different distribution. It appears to have a web-like or network structure that spreads over the organized iron without any apparent directional favor of its own. Additional measurements would be required to determine the speciation of the iron and cesium in the scans to understand the details of the barrier-cesium interaction.

Future work will look this interaction in detail and would also include investigation of other contaminants. In addition, iron patterns formed in the barrier in the presence of a magnetic field would be investigated. Also of interest is observation of changes in the surface characteristics either by chemical erosion or dissolution and patterns in the iron after long term exposure studies which would aid in the evaluation of long-term barrier stability.

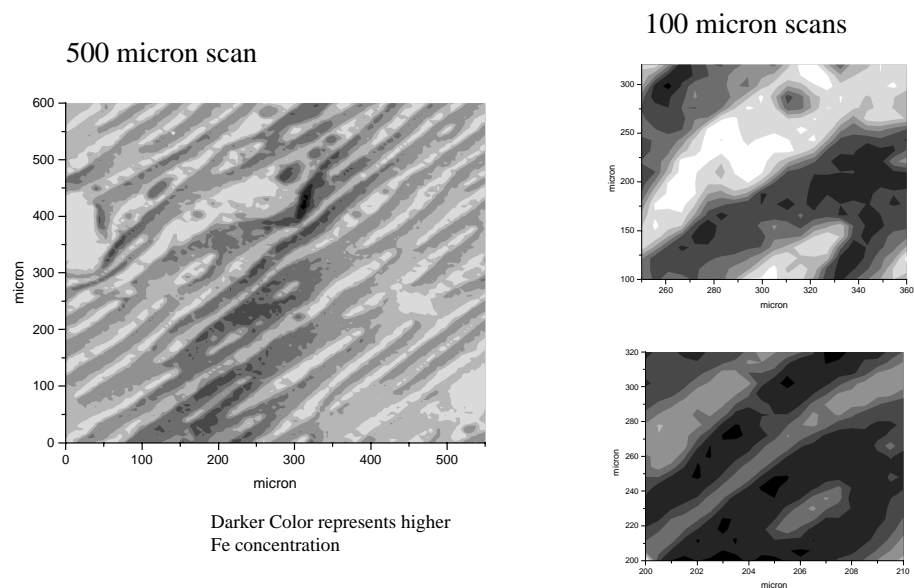


Figure 1: Elemental Scan of Fe in ferrofluid-colloidal barrier material gelled in the absence of a magnetic field showing self-organization

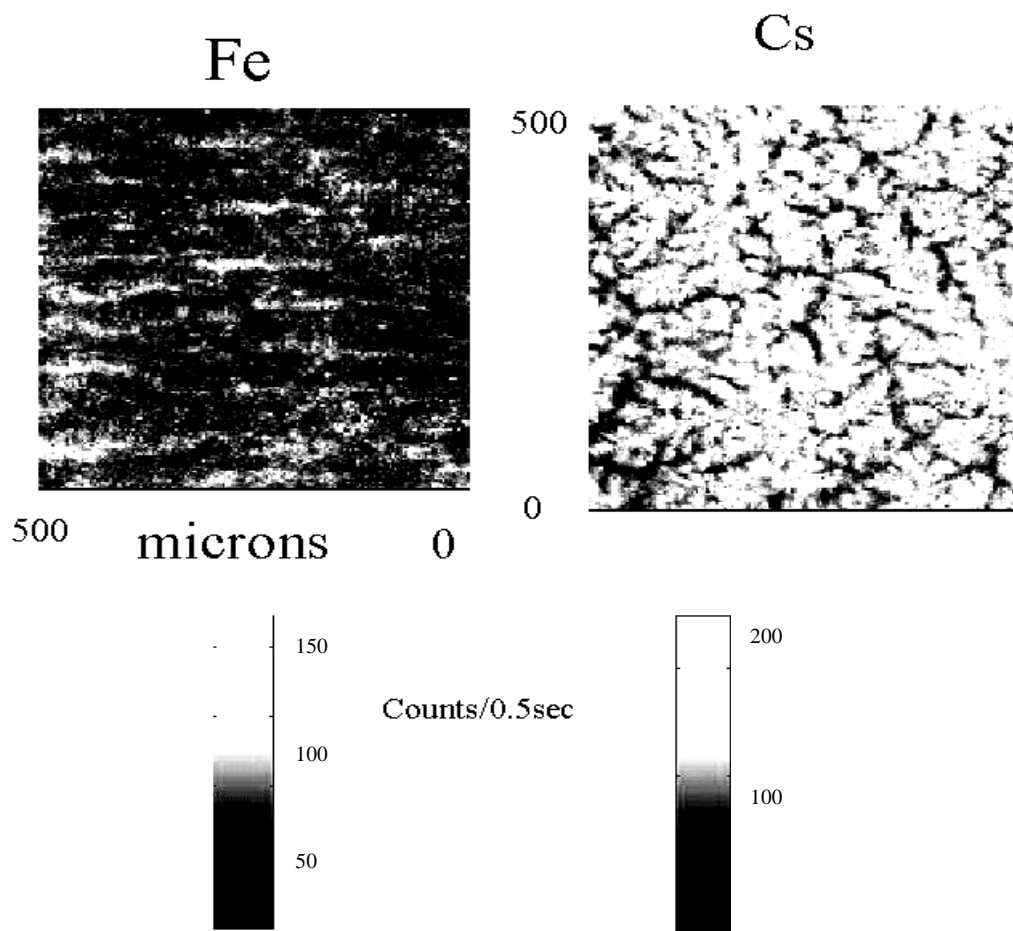


Figure 2. Magnetite in silica after exposure to CsCl solution

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Principal investigator: Sharon Borglin, Earth Sciences Division, Lawrence Berkeley National Laboratory.
Email: SEBorglin@lbl.gov. Telephone: 510 486-7515.